Pécs University Medical School
English Program

UNIVERSITAS QUINQUEECCLESIENSIS
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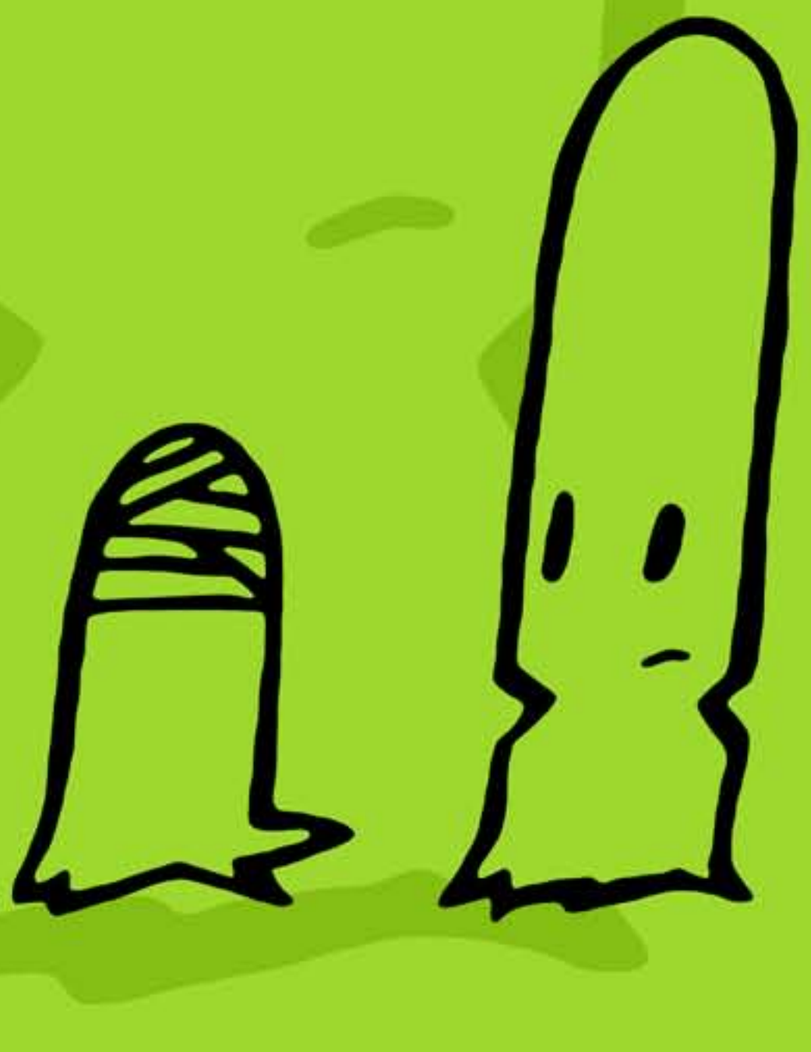
# a guide to MICROBIOLOGY 2ND SEMESTER



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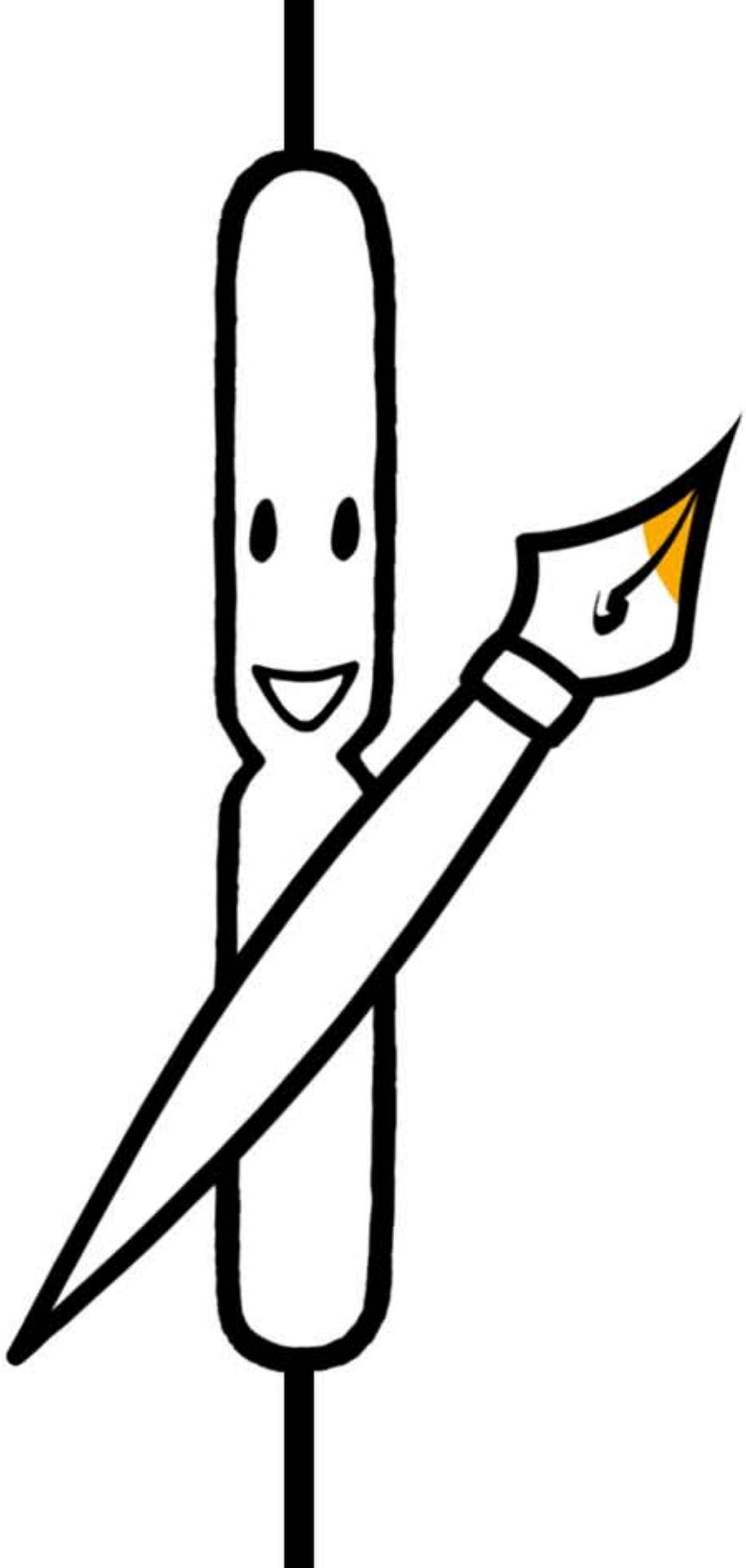

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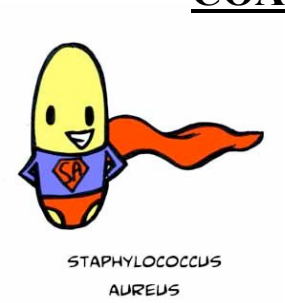
# 1. STAPHYLOCOCCUS AUREUS INFECTIONS

## *STAPHYLOCOCCUS*

**Characteristics**

- gram + (stains blue with gram stain)
- coccus (small, round cell)
- grow in grape-like cell clusters
- non-motile (has no flagellae)
- non-spore forming (does not form a sturdy vegetative infectious particle)
- facultative anaerobic (may survive in both oxygen-rich and oxygen-poor environments)

## COAGULASE + STAPHYLOCOCCI




### *Staphylococcus Aureus*

**Characteristics**

- non-encapsulated
- beta-hemolytic (completely lyses RBCs on blood agar, forms a clear halo around it's colonies on blood agar)
- opportunistic pathogen

**Reservoirs**

- humans (normal flora of the skin, nasopharynx, oropharynx and female genitalia)
- animals (primarily cattle)

**Transmission**

- direct contact ("person-to-person")
- perinatal ("mother-to-child")
- zoonotic ("animal-to-human")
- contaminated food

**Toxins**

- staphylococcal enterotoxin (causes ↑ secretion of histamine from mast cells → ↑ peristalsis → food poisoning, see below)
- exfoliatin (disrupts desmosomes of skin epithelium → scalded skin syndrome, see below)
- toxic shock syndrome toxin-1 ("TSST-1", causes massive activation of helper T-cells → massive IL-2 secretion → staphylococcal toxic shock syndrome, see below)

**Diseases**

- most common cause of skin infections (folliculitis, cellulitis and impetigo), skin abscesses (pustules, furuncles, carbuncles), and wound infections (together with Streptococcus Pyogenes, see 3)
- most common cause of acute infections endocarditis
- bronchopneumonia and pulmonary abscesses
- cystitis and renal abscesses (primarily if urinary catheter)
- meningitis and cerebral abscesses

- infective arthritis (primarily occurs in children and elderly) and osteomyelitis (primarily occurs in male children)
- septicemia (primarily if central venous catheter)

*Food Poisoning*
- most common cause of food poisoning
- gastroenteritis (abdominal pain, vomiting and watery diarrhea)
- spontaneously resolves in < 24 hours
- caused by Staphylococcus Aureus contamination of food → production and secretion of staphylococcal enterotoxin (see above) → ingestion of staphylococcal enterotoxin-containing food
- may progress to staphylococcal toxic shock syndrome (see below)

*Scalded Skin Syndrome*
- epidermal skin shedding
- primarily occurs around the umbilicus of neonates
- caused by Staphylococcus Aureus infection of skin → production and secretion of exfoliatin (see above)
- may progress to staphylococcal toxic shock syndrome (see below)

*Staphylococcal Toxic Shock Syndrome*
- "STSS"
- high fever, vomiting and watery diarrhea → diffuse erythematous rash and focal epidermal skin shedding → hypotension
- may lead to septic shock → death
- primarily occurs in menstruating females using tampons
- caused by Staphylococcus Aureus septicemia → production and secretion of TSST-1 (see above)

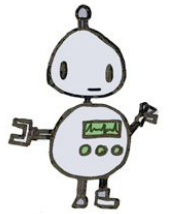
**Treatment**
- beta-lactamase resistant penicillins
- vancomycin (if resistant ot beta-lactamase resistant penicillins, "methicillin-resistant staphylococcus aureus", "MRSA")

*continued in 2…*

# 2. COAGULASE NEGATIVE STAPHYLOCOCCI

*...continuation of 1*

## COAGULASE - STAPHYLOCOCCI




### *Staphylococcus Epidermidis*

**Characteristics**
- encapsulated
- gamma-hemolytic (does not lyse RBCs on blood agar)
- opportunistic pathogen

**Reservoirs**
- humans (only reservoir, normal flora of the skin, nasopharynx, oropharynx and GI tract)

**Transmission**
- direct contact

**Toxins**
- none in particular

**Diseases**

*Nosocomial Infections*
- cystitis (primarily if urinary catheter)
- subacute infectious endocarditis (primarily if prosthetic heart valves)
- infective arthritis (primarily if prosthetic joints)
- septicemia (primarily if central venous catheter)

**Treatment**
- vancomycin
- trimethoprim-sulfamethoxazole

### *Staphylococcus Saprophyticus*

**Characteristics**
- non-encapsulated
- gamma-hemolytic
- obligate pathogen

**Reservoirs**
- humans (only reservoir, not normal flora)

**Transmission**
- direct contact

**Toxins**
- none in particular

**Diseases**
- second most common cause of cystitis (after Escherichia Coli, see 18, primarily occurs in sexually active females)

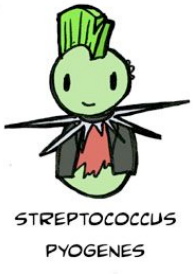
**Treatment**
- broad spectrum penicillins
- trimethoprim-sulfamethoxazole

# 3. STREPTOCOCCUS PYOGENES: PYOGENIC INFECTIONS
# 4. STREPTOCOCCUS PYOGENES: SCARLET FEVER AND SECONDARY STREPTOCOCCAL DISEASES

## *STREPTOCOCCUS*

**Characteristics**

- gram +
- coccus
- grow in chains or in pairs ("diplococci")
- non-motile
- non-spore forming
- facultative anaerobic
- classified according to the structure of the C carbohydrate in their respective cell walls ("lancefield antigen") as well as their respective hemolytic abilities




## *Streptococcus Pyogenes*

**Characteristics**

- encapsulated
- lancefield group A antigen ("group A Streptococcus")
- beta-hemolytic
- obligate pathogen

**Reservoirs**

- humans (only reservoir, not normal flora)

**Transmission**

- direct contact
- droplet nuclei ("respiratory spray")

**Toxins**

- pyrogenic exotoxin ("erythrogenic exotoxin", causes scarlet fever and streptococcal toxic shock-like syndrome, see below)

**Diseases**

*Invasive Diseases*

- most common cause of skin infections (folliculitis, cellulitis and impetigo), skin abscesses (pustules, furuncles, carbuncles), and wound infections (together with Staphylococcus Aureus, see 1)
- most common BACTERIAL cause of acute pharyngitis ("acute tonsillitis", "strep throat")
- otitis media and mastoiditis
- subacute infectious endocarditis
- septicemia

*Cross Reactive Diseases*

- rheumatic fever
- acute post-streptococcal glomerulonephritis ("diffuse proliferative glomerulonephritis")

*Scarlet Fever*

- high fever and diffuse, brightly erythematous ("scarlet-red") rash beginning on the trunk and neck and then progressing to the extremities → shedding of the affected skin
- caused by Streptococcus Pyogenes septicemia → production and secretion of pyrogenic exotoxin (see above)
- may progress to streptococcal toxic shock-like syndrome (see below)

*Streptococcal Toxic Shock-Like Syndrome*

- "STLS"
- analogous to staphylococcal toxic shock syndrome (see 1)
- caused by Streptococcus Pyogenes septicemia → production and secretion of pyrogenic exotoxin (see above)

**Treatment**

- narrow spectrum penicillins
- beta-lactamase resistant penicillins (if skin infections, due to the possibility that the skin infections might be of Staphylococcus Aureus origin, see 1)

*continued in 5…*

# 5. STREPTOCOCCUS PNEUMONIAE

*...continuation of 3/4*

## *Streptococcus Pneumoniae ("Pneumococcus")*

**Characteristics**
- encapsulated
- no lancefield antigen
- alpha-hemolytic (partially lyses RBCs on blood agar, forms a greenish halo around it's colonies on blood agar)
- opportunistic pathogen

**Reservoirs**
- humans (only reservoir, normal flora of the nasopharynx, oropharynx and conjunctiva)

**Transmission**
- direct contact
- droplet nuclei
- contaminated fomites (indigestible objects)

**Toxins**
- none in particular

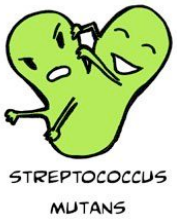
**Diseases**
- most common cause of lobar pneumonia and pulmonary abscesses
- most common cause of meningitis and cerebral abscesses
- most common cause of otitis media (primarily occurs in children)
- sinusitis
- subacute infectious endocarditis and acute pericarditis
- septicemia

**Treatment**
- narrow spectrum penicillins
- macrolides

*continued in 6/7...*

# 6. THE "STREPTOCOCCUS VIRIDANS" GROUP, THEIR ROLE IN CARIOGENESIS
# 7. ENDOCARDITIS LENTA AND ITS BACTERIAL DIAGNOSIS

*...continuation of 5*




## *Streptococcus Viridans*

**Species**
- S. Mutans
- S. Intermedius
- S. Salivarius

**Characteristics**
- non-encapsulated
- no lancefield antigen
- alpha-hemolytic
- opportunistic pathogen

**Reservoirs**
- humans (only reservoir, normal flora of the skin, nasopharynx, oropharynx and oral cavity)

**Transmission**
- perinatal

**Toxins**
- none in particular

**Diseases**
- most common cause of dental caries (primarily caused by S. Mutans)
- most common cause of subacute infectious endocarditis ("endocarditis lenta", caused by all species of Streptococcus Viridans)
- cerebral abscesses and hepatic abscesses (primarily caused by S. Intermedius)
- septicemia (caused by all species of Streptococcus Viridans)

**Treatment**
- narrow spectrum penicillins
- broad spectrum penicillins in conjunction with aminoglycosides (if subacute infectious endocarditis, due to the possibility that the subacute infectious endocarditis might be of enterococcus faecialis origin, see 8)

*continued in 8...*

# 8. STREPTOCOCCUS AGALACTIAE, ENTEROCOCCUS FAECIALIS

*...continuation of 6/7*

## *Streptococcus Agalactiae*

**Characteristics**
- encapsulated
- lancefield group B antigen ("group B Streptococcus")
- beta-hemolytic
- opportunistic pathogen

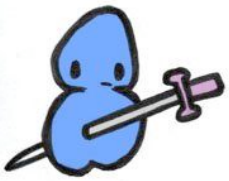
**Reservoirs**
- humans (normal flora of the GI tract and female genitalia)
- animals

**Transmission**
- perinatal

**Toxins**
- none in particular

**Diseases**
- most common cause of neonatal pneumonia
- most common cause of neonatal meningitis
- cystitis and endometritis
- endocarditis and peritonitis
- infective arthritis and osteomyelitis
- septicemia

**Treatment**
- narrow spectrum penicillins
- aminoglycosides (if neonatal meningitis, due to the possibility that the neonatal meningitis might be of Escherichia Coli origin, see 19)




# *Streptococcus Faecalis ("Enterococcus Faecalis")*

**Characteristics**
- non-encapsulated
- lancefield group D antigen ("group D Streptococcus")
- alpha-hemolytic
- facultative alkaliphilic (may survive in both both neutral- and alkaline environments, thus may grow in bile)
- opportunistic pathogen

**Reservoirs**
- humans (normal flora of the GI tract)
- animals

**Transmission**
- trauma

**Toxins**
- none in particular

**Diseases**
- second most common cause of subacute infectious endocarditis (after Streptococcus Viridans, see 7)
- wound infections
- cholecystitis (due to it's facultative alkaliphilic nature, see above)
- cystitis
- septicemia

**Treatment**
- broad spectrum penicillins in conjunction with aminoglycosides (due to high antibiotic resistance)
- vancomycin (if resistant to broad spectrum penicillins and/or aminoglycosides)

# 9. PEPTOCOCCUS AND PEPTOSTREPTOCOCCUS

## *PEPTOCOCCUS*

**Species**
- P. Niger (all other species that previously were part of the Peptococcus genus are now part of the Peptostreptococcus genus, see below)

**Characteristics**
- gram +
- coccus
- grow in chains or in pairs
- non-encapsulated
- non-motile
- non-spore forming
- gamma-hemolytic
- opportunistic pathogen

**Reservoirs**
- humans (normal flora of the nasopharynx, oropharynx, GI tract and female genitalia)
- animals
- soil

**Transmission**
- trauma

**Toxins**
- none in particular

**Diseases**
- wound infections (primarily if surgical)
- otitis media and mastoiditis
- sinusitis
- bronchopneumonia and pulmonary abscesses
- appendicitis, peritonitis and hepatic abscesses
- cystitis
- vulvovaginitis and pelvic inflammatory disease ("PID", endometritis, salpingitis and oophitis)
- meningitis and cerebral abscesses
- infective arthritis and osteomyelitis
- septicemia

**Treatment**
- narrow spectrum penicillins
- clindamycin

# *PEPTOSTREPTOCOCCUS*

**Species**
- P. Aerobius
- P. Magnus
- P. Micros

**Characteristics**
- same characteristics, reservoirs, transmission, toxins, diseases and treatment as Peptococcus (see above, Peptostreptococcus only differs from Peptococcus in it's genome and the amino acid sequence of it's proteins)

# 10. NEISSERIA GONORRHOEAE

## *NEISSERIA*

**Characteristics**

- gram - (does not stain with gram stain, but stains red with gram contrastain)
- curved coccus
- grow in pairs
- non-motile
- non-spore forming
- facultative anaerobic
- facultative intracellular (may survive both extracellularly and intracellularly)

## *Neisseria Gonorrhoeae ("Gonococcus")*

**Characteristics**

- non-encapsulated
- obligate pathogen

**Reservoirs**

- humans (only reservoir, not normal flora)

**Transmission**

- sexual ( "sexually transmitted disease", "STD", "venereal disease")
- perinatal

**Toxins**

- lipooligosaccaride ("LOS", analogous to LPS, see 12)

**Diseases**

*In Males*

- gonorrheal urethritis ("gonorrhea")
- prostatitis and epididymitis

*In Females*

- gonorrheal urethritis and cervicitis ("gonorrhea")
- pelvic inflammatory disease (see 9), tuboovarian abscesses, ectopic pregnancies and infertility

*In Both Males and Females*

- pharyngitis (primarily if oral intercourse)
- proctitis (primarily if anal intercourse)
- meningitis and subacute infectious endocarditis
- dermatitis in conjunction with infective arthritis ("dermatitis-arthritis syndrome")
- septicemia

*In Neonates*

- conjunctivitis and blindness

**Treatment**

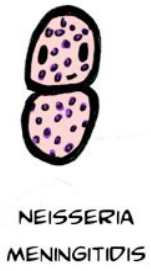
- third generation cephalosporins

- third generation cephalosporins in conjunction with tetracyclines (if gonorrheal urethritis and/or cervicitis, due to the possibility that the urethritis and/or cervicitis may be of Chlamydia Trachomatis (see 45) or Ureaplasma Urealyticum (see 46) origin)

*continued in 11…*

# 11. NEISSERIA MENINGITIDIS

*...continuation of 10*




## *Neisseria Meningitidis ("Meningococcus")*

**Characteristics**
- encapsulated
- opportunistic pathogen

**Reservoirs**
- humans (only reservoir, normal flora of the nasopharynx)

**Transmission**
- direct contact
- droplet nuclei

**Toxins**
- LOS (see 10)

**Diseases**

*Meningococcemia*
- spiking fever, diffuse petechial skin rashes and infective arthritis
- caused by Neisseria Meningitidis septicemia
- may progress to meningitis and/or waterhouse-friderichsen syndrome (see below)

*Meningitis*
- intense headache, vomiting and stiff neck → delirium → coma
- permanent central neuropathies upon recovery
- caused by progression of meningococcemia (see above)

*Waterhouse-Friderichsen Syndrome*
- "fulminant meningococcemia"
- DIC → severe bilateral adrenal hemorrhage → adrenal crisis
- > 50% mortality if untreated (within 6-8 hours (!))
- caused by progression of meningococcemia (see above)

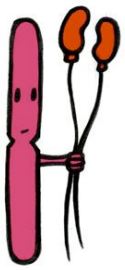
**Treatment**
- narrow spectrum penicillins
- third generation cephalosporins

# 12. ENTEROPATHOGENIC (EPEC), ENTEROTOXIGENIC (ETEC) AND ENTEROHEMORRHAGIC (EHEC) ESCHERICHIA COLI

## *ESCHERICHIA*

**Characteristics**

- gram -
- rod (thin, elongated cell)
- encapsulated
- motile (has flagellae)
- non-spore forming
- facultative anaerobic




### *Escherichia Coli*

**Characteristics**

- opportunistic pathogen

**Reservoirs**

- humans (normal flora of the GI tract)
- animals

**Transmission**

- direct contact
- fecal-oral
- contaminated water
- contaminated food
- contaminated fomites

### Enteropathogenic Escherichia Coli ("EPEC")

**Characteristics** - gamma-hemolytic

**Toxins** - lipopolysaccaride ("LPS", "endotoxin")

**Diseases** - watery diarrhea (primarily occurs in infants)

**Treatment** - oral fluid and electrolyte replacement

## Enterotoxigenic Escherichia Coli ("ETEC")

**Characteristics**
- gamma-hemolytic

**Toxins**
- heat-labile enterotoxin ("LT", inhibits the GTPase domain of adenylate cyclase → ↑ cAMP → ↑ $Cl^-$ and $HCO_3^-$ secretion → ↑ intraluminal osmotic pressure → osmotic diarrhea (see below), analogous to choleragen (see 23))
- heat-stabile enterotoxin ("ST", inhibits the GTPase domain of guanylate cyclase → ↑ cGMP → same effect as LT, see above)
- LPS

**Diseases**
- most common BACTERIAL cause of gastroenteritis ("traveler's diarrhea", "montezuma's revenge", see 1, primarily occurs in travelers)

**Treatment**
- oral fluid and electrolyte replacement

## Enterohemorrhagic Escherichia Coli ("EHEC")

**Characteristics**
- gamma-hemolytic

**Toxins**
- verotoxin ("shiga-like toxin", "SLT", inhibits the 60S ribosomal subunit → ↓ protein synthesis → necrosis and inflammation → hemorrhagic colitis and hemolytic uremic syndrome (see below), analogous to shiga toxin (see 13))
- LPS

**Diseases**

*Hemorrhagic Colitis*
- low-grade fever, abdominal cramps, abdominal pain, vomiting and purulent hemorrhagic diarrhea
- spontaneously resolves in < 1 week
- caused by EHEC infection of the GI tract → production and secretion of verotoxin (see above) → necrosis of the enterocytes
- may progress to hemolytic-uremic syndrome (see below)

*Hemolytic-Uremic Syndrome*
- "HUS"
- thrombosis and following thrombocytopenia → sequestration of RBCs passing through the thrombi and following hemolytic anemia → occlusion of the glomeruli by the thrombi and following intrarenal azotemia and uremia
- most common cause of hemolytic-uremic syndrome
- caused by verotoxin (see above) toxemia → necrosis of the glomerular endothelial cells

**Treatment**
- oral fluid and electrolyte replacement (if hemorrhagic

## Uropathogenic Escherichia Coli ("UPEC")

## Uropathogenic Escherichia Coli ("UPEC")

**Characteristics**
- beta-hemolytic

**Toxins**
- cytotoxic necrosis factor ("CNF", causes necrosis of the transitional epithelial cells of the urinary tract → cystitis and/or pyelonephritis, see below)
- LPS

**Diseases**
- most common cause of cystitis (primarily occurs in sexually active females) and pyelonephritis

**Treatment**
- fluoroquinolones
- trimethoprim-sulfamethoxazole

## Meningitis-Associated Escherichia Coli ("MNEC")

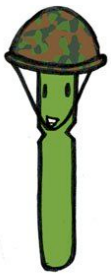
**Characteristics**
- gamma-hemolytic

**Toxins**
- cytotoxic necrosis factor ("CNF", causes necrosis of the meningeal endothelial cells → neonatal meningitis, see below)
- LPS

**Diseases**
- second most common cause of neonatal meningitis (after Streptococcus Agalactiae, see 8)
- most common cause of septicemia

**Treatment**
- aminoglycosides (if neonatal meningitis, due to the possibility that the neonatal meningitis might be of Streptococcus Agalactiae origin, see 8)
- fluoroquinolones (if septicemia)

# 13. BACILLARY DYSENTERY




## *SHIGELLA*

**Species**
- S. Dysenteriae
- S. Flexneri
- S. Boydii

**Characteristics**
- gram -
- rod
- non-encapsulated
- non-motile
- non-spore forming
- facultative anaerobic
- facultative intracellular
- obligate pathogen

**Reservoirs**
- humans (only reservoir, not normal flora)

**Transmission**
- direct contact
- fecal-oral
- vectorial (flies)
- contaminated water
- contaminated food

**Toxins**
- shiga toxin (analogous to verotoxin (see 12), causes hemorrhagic bacillary dysentery and hemolytic-uremic syndrome (see below))
- LPS

**Diseases**

*Bacillary Dysentery*
- low-grade fever, abdominal cramps, abdominal pain, vomiting and purulent hemorrhagic diarrhea
- spontaneously resolves in < 1 week
- primarily occurs in children and elderly
- analogous to hemorrhagic colitis (see 12)
- caused by Shigella infection of the GI tract → production and secretion of shiga toxin (see above) → necrosis of the enterocytes

*Hemolytic-Uremic Syndrome*
- see 12

**Treatment**
- broad spectrum penicillins in conjunction with oral fluid and electrolyte replacement (if bacillary dysentery)
- broad spectrum penicillins in conjunction with careful oral fluid and electrolyte replacement (if hemolytic-uremic syndrome, due to occlusion of the glomeruli, see 12)

# 14. SALMONELLAE CAUSING ENTERIC FEVER

## *SALMONELLA*

**Characteristics**
- gram -
- rod
- encapsulated
- motile
- non-spore forming
- facultative anaerobic
- facultative intracellular
- facultative alkaliphilic

### *Salmonella Typhi*

**Characteristics**
- obligate pathogen

**Reservoirs**
- humans (only reservoir, not normal flora)

**Transmission**
- direct contact
- fecal-oral
- contaminated water
- contaminated food

**Toxins**
- LPS

**Diseases**

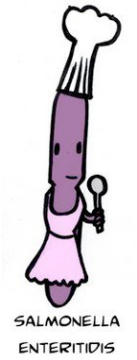
*Typhoid Fever*
- "enteric fever"
- enterocolitis (high fever, headache, abdominal pain, vomiting and watery diarrhea) and mesenteric lymphadenitis ("mock appendicitis") → abdominal rash ("rose spots"), hepatosplenomegaly and generalized lymphadenomegaly
- caused by phagocytosis of Salmonella Typhi by macrophages of the gut-associated lymphoid tissue ("GALT") → survival of Salmonella Typhi within the macrophages → dissemination of Salmonella Typhi in virtually every lymphoid organ

**Treatment**
- broad spectrum penicillins
- third generation cephalosporins

*continued in 15…*

# 15. SALMONELLA GASTROENTERITIS

*...continuation of 14...*




## *Salmonella Enteritidis*

**Characteristics**
- obligate pathogen

**Reservoirs**
- humans (<u>not</u> normal flora)
- animals (primarily cattle and poultry)

**Transmission**
- direct contact
- fecal-oral
- zoonotic
- contaminated food (primarily meat, milk and eggs)

**Toxins**
- LPS

**Diseases** *Salmonellosis*
- gastroenteritis (see 1)
- spontaneously resolves in < 1 week
- caused by Salmonella Enteritidis infection of the GI tract

**Treatment**
- oral fluid and electrolyte replacement

# 16. YERSINIA ENTEROCOLITICA AND YERSINIA PSEUDOTUBERCULOSIS

## *YERSINIA*

**Characteristics**

- gram -
- bipolar (the extremities take up more stain than the center) rod
- non-spore forming
- facultative anaerobic
- facultative intracellular

## *Yersinia Enterocolitica*

**Characteristics**

- motile
- non-encapsulated
- obligate pathogen

**Reservoirs**

- humans (not normal flora)
- animals (primarily swine, cattle and birds)

**Transmission**

- direct contact
- fecal-oral
- zoonotic
- contaminated water
- contaminated food (primarily meat and milk)

**Toxins**

- yersinial enterotoxin (analogous to ST (see 12), causes enterocolitis (see below))
- LPS

**Diseases**

- enterocolitis (see 14, primarily occurs in children and in immunocompromised) and mesenteric lymphadenitis ("mock appendicitis")
- cellulitis, iritis and pharyngitis
- infective arthritis and osteomyelitis
- septicemia

**Treatment**

- oral water and electrolyte replacement (if enterocolitis)
- third generation cephalosporins (if septicemia)

## *Yersinia Pseudotuberculosis*

**Characteristics**

- same characteristics, reservoirs, transmission, diseases and treatment as Yersinia Enterocolitica (see above, only differs in toxins secreted, see below)
- (also causes a disseminated tuberculosis-like syndrome in animals, thus "Pseudotuberculosis")

**Toxins**

- cytotoxic necrosis factor ("CNF", causes necrosis of the enterocytes of the small intestine → enterocolitis, see above)
- LPS

*continued in 17…*

# 17. YERSINIA PESTIS

*...continuation of 16*

## *Yersinia Pestis*

**Characteristics**
- encapsulated
- non-motile
- obligate pathogen

**Reservoirs**
- humans (only in epidemic periods, not normal flora)
- animals (primarily rats and other rodents)

**Transmission**
- droplet nuclei (only in epidemic periods)
- zoonotic
- vectorial (fleas)

**Toxins**
- LPS

**Diseases**

*The Bubonic Plague*
- "the black death"
- fever and severe focal lymphadenomegaly ("buboae")
- caused by phagocytosis of Yersinia Pestis by macrophages → dissemination of Yersinia Pestis in regional lymph nodes
- may progress to the septic plague (see below)

*The Septicemic Plague*
- large black gangrenous hemorrhages of the skin, meninges, GI tract and genitourinary tract
- > 50% mortality if untreated (within 3-6 days (!))
- caused by Yersinia Pestis septicemia
- may progress to the pneumonic plague (see below)

*The Pneumonic Plague*
- pneumonia and severe black gangrenous hemorrhages of the lungs
- > 75% mortality if untreated (within 2-4 days (!))
- caused by secondary septicemic spread of Yersinia Pestis to the respiratory tract or by primary inhalation of droplet nuclei (only in epidemic periods)

**Treatment**
- aminoglycosides
- tetracyclines

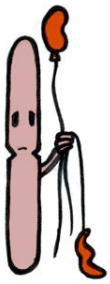
# 18. URINARY ESCHERICHIA COLI INFECTIONS

*see 12…*

# 19. NEONATAL MENINGITIS AND SEPSIS CAUSED BY ESCHERICHIA COLI

*see 12…*

# 20. PROTEUS, PROVIDENCIA




## *PROTEUS*

**Species**
- P. Mirabilis
- P. Vulgaris
- P. Penneri

**Characteristics**
- gram -
- rod
- motile
- non-spore forming
- non-encapsulated
- facultative anaerobic
- opportunistic pathogen

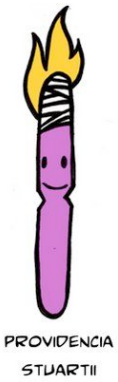
**Reservoirs**
- humans (normal flora of the GI tract)
- water
- soil

**Transmission**
- fecal-oral
- direct contact
- contaminated water

**Toxins**
- LPS

**Diseases**
- wound infections
- bronchopneumonia
- cystitis and urolithiasis
- septicemia

**Treatment**
- cephalosporins
- aminoglycosides




# *PROVIDENCIA*

**Species**
- P. Stuartii
- P. Rettgeri
- P. Alcalifaciens

**Characteristics**
- same characteristics, reservoirs, transmission and toxins as Proteus (see above, only differs in diseases and treatment, see below)

**Diseases**
- gastroenteritis (see 1, primarily occurs in travelers)
- wound infections (primarily if burned)
- bronchopneumonia (primarily if intubated)
- cystitis (primarily if urinary catheter) and urolithiasis
- septicemia

**Treatment**
- fluoroquinolones
- tetracyclines

# 21. KLEBSIELLA, ENTEROBACTER, CITROBACTER

## *KLEBSIELLA*

**Species**
- K. Pneumoniae
- K. Rhinoscleromatis
- K. Ozeanae

**Characteristics**
- gram -
- rod
- encapsulated
- non-motile
- non-spore forming
- facultative anaerobic
- opportunistic pathogen

**Reservoirs**
- humans (normal flora of the skin, nasopharynx, oropharynx and GI tract)
- animals
- water
- soil

**Transmission**
- direct contact
- fecal-oral
- contaminated fomites

**Toxins**
- LPS

**Diseases**
- second most common cause of lobar pneumonia and pulmonary abscesses (after Streptococcus Pneumoniae, see 5, primarily caused by K. Pneumoniae)
- rhinoscleroma (granulomas of both the upper and lower respiratory tract → airway obstruction, primarily caused by K. Rhinoscleromatis)
- ozena (atrophic rhinitis in conjunction with chronic sinusitis, primarily caused by K. Ozaenae)
- wound infections (primarily if burned, caused by all species of Klebsiella)
- cystitis (primarily if urinary catheter, caused by all species of Klebsiella)
- second most common cause of septicemia (after MNEC, see 12, caused by all species of Klebsiella)

**Treatment**
- third generation cephalosporins
- fluoroquinolones

# *ENTEROBACTER*

**Species**
- E. Aerogenes
- E. Agglomerans
- E. Cloacae

**Characteristics**
- gram -
- rod
- encapsulated
- motile
- non-spore forming
- facultative anaerobic
- opportunistic pathogen

**Reservoirs**
- humans (normal flora of the GI tract)
- animals
- water
- soil

**Transmission**
- direct contact
- fecal-oral
- contaminated fomites

**Toxins**
- LPS

**Diseases**

*Nosocomial Infections*
- skin infections (folliculitis, cellulitis and impetigo), skin abscesses (pustules, furuncles, carbuncles), and wound infections
- bronchopneumonia and pulmonary abscesses
- cystitis and renal abscesses (primarily if urinary catheter)
- neonatal meningitis and cerebral abscesses
- subacute infectious endocarditis
- osteomyelitis and arthritis
- septicemia

**Treatment**
- aminoglycosides
- tetracyclines

# *CITROBACTER*

**Species**
- C. Diversus
- C. Freundii
- C. Amalonaticus

**Characteristics**
- gram -
- rod
- encapsulated
- motile
- non-spore forming
- facultative anaerobic
- opportunistic pathogen

**Reservoirs**
- humans (normal flora of the GI tract)
- animals
- water

**Transmission**
- fecal-oral
- direct contact
- perinatal
- contaminated food

**Toxins**
- LPS

**Diseases**
- neonatal meningitis and cerebral abscesses (caused primarily by C. Diversus)
- cystitis and renal abscesses (especially if urinary catheter, caused by all species of Citrobacter)
- septicemia (caused by all species of Citrobacter)

**Treatment**
- aminoglycosides
- chloramphenicol

# 22. CAMPYLOBACTER, HELICOBACTER

## *CAMPYLOBACTER*

**Characteristics**
- gram -
- helical rod
- motile
- non-spore forming
- non-encapsulated
- aerobic and microaerophilic (may survive in relatively oxygen-poor environments)
- facultative alkaliphilic
- facultative intracellular

### *Campylobacter Jejuni*

**Characteristics**
- obligate pathogen

**Reservoirs**
- humans (not normal flora)
- animals (primarily cattle and poultry)

**Transmission**
- fecal-oral
- direct contact
- zoonotic
- contaminated food (primarily meat and milk)

**Toxins**
- campylobacteral enterotoxin (analogous to choleragen (see 23), causes gastroenteritis (see below))
- cytolethal distending toxin ("CDT", DNase, causes double-stranded DNA-breaks → necrosis and inflammation → hemorrhagic colitis and hemolytic-uremic syndrome, see below)
- LPS

**Diseases** *In Children*
- second most common BACTERIAL cause of gastroenteritis (see 1, after ETEC, see 12)
- hemorrhagic colitis and hemolytic-uremic syndrome (see 12)
- septicemia

**Treatment**
- oral water and electrolyte replacement (if gastroenteritis and/or hemorrhagic colitis)
- aminoglycosides (if hemolytic-uremic syndrome and/or septicemia)

### *Campylobacter Fetus*

**Characteristics**
- opportunistic pathogen

**Reservoirs**
- humans (not normal flora)
- animals (primarily cattle, sheep and goats)

**Transmission**
- direct contact
- fecal-oral
- zoonotic
- contaminated food

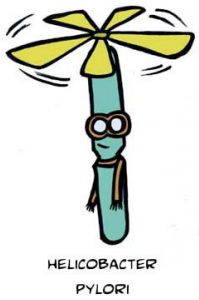
**Toxins**
- LPS

**Diseases**
*In Immunocompromized*
- meningitis, pleuritis, pericarditis and synovitis
- septicemia

**Treatment**
- aminoglycosides
- macrolides

## *HELICOBACTER*

**Characteristics**
- gram -
- helical rod
- motile
- non-spore forming
- non-encapsulated
- aerobic and microaerophilic
- facultative alkaliphilic
- facultative intracellular




# *Helicobacter Pylori*

**Characteristics**
- obligate pathogen

**Reservoirs**
- humans (not normal flora)
- animals (primarily cats)

**Transmission**
- fecal-oral
- zoonotic

**Toxins**
- vacuolating cytotoxin A ("VacA", causes chronic atrophic gastritis, gastric adenocarcinoma and MALToma, see below)
- LPS

**Diseases**
- most common cause of duodenal ulcers
- second most common cause of gastric ulcers (after aspirin)
- acute erosive gastritis
- chronic atrophic gastritis
- gastric adenocarcinoma and MALToma

**Treatment**
- hydrogen ion/potassium antiporter inhibitors (if duodenal ulcers, gastric ulcers and/or acute erosive gastritis)
- metronidazole in conjunction with broad spectrum penicillins (if chronic atrophic gastritis, gastric adenocarcinoma and/or MALToma)

# 23. VIBRIO AND AEROMONAS

## *VIBRIO*

**Characteristics**

- gram -
- curved rod
- motile
- non-spore forming
- non-encapsulated
- facultative anaerobic
- facultative alkaliphilic

### *Vibrio Cholerae*

**Characteristics**

- obligate isotonic (may only survive in isotonic environments)
- obligate pathogen

**Reservoirs**

- humans (not normal flora)
- water

**Transmission**

- fecal-oral
- contaminated water
- contaminated food

**Toxins**

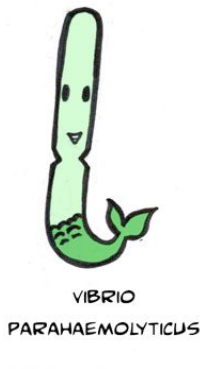
- choleragen (analogous to LT (see 12) causes cholera gravis (see below))
- LPS

**Diseases** *Cholera Gravis*

- severe watery diarrhea (>25 liter per day)
- may lead to hypovolemia → hypovolemic shock
- > 50% mortality if untreated (within hours (!))
- caused by Cholera Gravis infection of the GI tract → production and secretion of choleragen (see above)

**Treatment**

- oral water and electrolyte replacement
- tetracyclines




## *Vibrio Parahaemolyticus*

**Characteristics**
- facultative hypertonic ("halophilic", may survive in both isotonic and hypertonic environments, thus may survive in salt water)
- obligate pathogen

**Reservoirs**
- humans (not normal flora)
- water (both fresh and salt water)
- animals (primarily fish and crustaceans)

**Transmission**
- fecal-oral
- contaminated water
- contaminated food (primarily seafood)

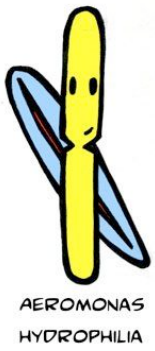
**Toxins**
- RTX toxin (causes gastroenteritis, hemorrhagic colitis and hemolytic-uremic syndrome, see below)
- LPS

**Diseases**
- wound infections
- gastroenteritis (see 1)
- hemorrhagic colitis and hemolytic-uremic syndrome (see 12)
- septicemia

**Treatment**
- oral water and elecrolyte replacement (if gastroenteritis, hemorrhagic colitis and/or hemolytic-uremic syndrome)
- tetracyclines (if wound infections and/or septicemia)

## *AEROMONAS*

**Characteristics**
- gram -
- rod
- motile
- non-spore forming
- non-encapsulated
- facultative anaerobic
- facultative hypertonic




# *Aeromonas Hydrophilia*

**Characteristics**
- obligate pathogen

**Reservoirs**
- humans (not normal flora)
- water (both fresh and salt water)
- soil

**Transmission**
- fecal-oral
- contaminated water
- contaminated soil
- contaminated food (primarily seafood)

**Toxins**
- aeromonas heat-labile enterotoxin ("ALT", "cytotonic enterotoxin", analogous to choleragen (see 23), causes gastroenteritis (see below))
- LPS

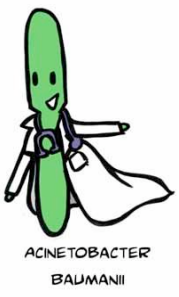
**Diseases**
- gastroenteritis (see 1)
- wound infections (primarily if leech bites)
- endophthalmitis, keratitis and corneal ulcers
- bronchopneumonia
- cystitis
- septicemia

**Treatment**
- oral fluid and electrolyte replacement (if gastroenteritis)
- tetracyclines (if all other diseases)

# 24. ACINETOBACTER

## *ACINETOBACTER*

**Characteristics**
- gram -
- pleomorphic rod (rod in log phase, coccobacillary rod (short truncated rod) in stationary phase)
- encapsulated
- non-motile
- non-spore forming
- obligate aerobic




### *Acinetobacter Baumanii*

**Characteristics**
- opportunistic pathogen

**Reservoirs**
- humans (normal flora of the skin)
- water
- soil

**Transmission**
- direct contact
- droplet nuclei
- contaminated water
- contaimanted soil
- contaminated fomites

**Toxins**
- LPS

**Diseases**

*Nosocomial Infections*
- wound infections (primarily if surgical)
- bronchopneumonia (primarily if intubated)
- peritonitis (primarily if continuous ambulatory peritoneal dialysis)
- cystitis (primarily if urinary catheter)
- meningitis (primarily if external ventricular drainage catheter)
- septicemia

**Treatment**
- carbapenems
- polymixins

# 25. PSEUDOMONAS AERUGINOSA

## *PSEUDOMONAS*

**Characteristics**
- gram -
- rod
- encapsulated
- motile
- non-spore forming
- obligate aerobic

## *Pseudomonas Aeruginosa*

**Characteristics**
- opportunistic pathogen

**Reservoirs**
- humans (normal flora of the GI tract)
- water
- soil

**Transmission**
- direct contact
- droplet nuclei
- contaminated water
- contaimanted soil
- contaminated fomites

**Toxins**
- exotoxin A ("exoA", ribosylates elongation factor 2 → ↓ protein synthesis → necrosis and inflammation, analogous to diphtheria toxin, see 34)
- LPS

**Diseases**

*In Healthy*
- endophthalmitis, keratitis and corneal ulcers (primarily if contact lenses)
- otitis externa ("swimmer's ear")

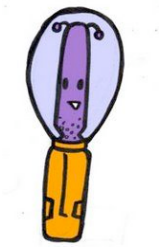
*In Immunocompromized*
- second most common cause of acute infectious endocarditis (after Staphylococcus Aureus, see 1)
- wound infections (primarily if burned)
- tracheobronchitis and bronchopneumonia (primarily if intubated)
- chronic bronchopneumonia and severe progressive pulmonary abscesses (primarily if cystic fibrosis)
- cystitis and pyelonephritis (primarily if catheterized)
- meningitis (primarily if external ventricular drainage catheter)
- septicemia

**Treatment**
- extended spectrum penicillins in conjunction with aminoglycosides (due to high antibiotic resistance)

# 26. HAEMOPHILUS INFLUENZAE, H. PARAINFLUENZAE

## *HAEMOPHILUS*

**Characteristics**
- gram -
- pleomorphic rod
- non-motile
- non-spore forming
- facultative anaerobic




### *Haemophilus Influenzae*

**Characteristics**
- encapsulated
- opportunistic pathogen

**Reservoirs**
- humans (only reservoir, normal flora of the nasopharynx, oropharynx, oral cavity and conjunctiva)

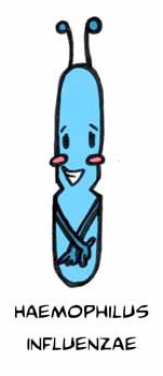
**Transmission**
- droplet nuclei

**Toxins**
- LPS

**Diseases**

*In Neonates and Children*
- acute laryngoepiglottitis ("obstructive laryngoepiglottitis")
- meningitis
- infective arthritis and osteomyelitis
- septicemia

**Treatment**
- third generation cephalosporins
- chloramphenicol




## *Haemophilus Parainfluenzae*

**Characteristics**

- non-encapsulated
- opportunistic pathogen
- same reservoirs, transmission and toxins as Hemophilus Influenzae, see above)

**Diseases**

*In Teenagers and Adults*

- otitis media and mastoiditis
- sinusitis
- bronchopneumonia (primarily if viral interstitial pneumonitis and/or chronic bronchitis is already present)
- subacute infectious endocarditis
- septicemia

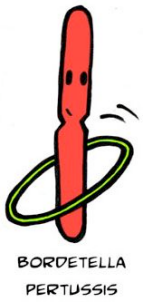
**Treatment**

- broad spectrum penicillins
- broad spectrum penicillins in conjunction with beta-lactamase inhibitors (if resistant to broad spectrum penicillins)

# 27. BORDETELLA PERTUSSIS, B. PARAPERTUSSIS, B. BRONCHISEPTICA

## *BORDETELLA*

**Characteristics**
- gram -
- coccobacillary rod
- encapsulated
- non-spore forming
- obligate aerobic




### *Bordetella Pertussis*

**Characteristics**
- non-motile
- obligate pathogen

**Reservoirs**
- humans (only reservoir, not normal flora)

**Transmission**
- direct contact
- droplet nuclei

**Toxins**
- tracheal cytotoxin ("TCT", disrupts mitochondria of bronchial ciliated epithelial cells → ↑ cytochrome c release → ↑ activation of caspases → apoptosis → ↓ mucociliary clearance → pertussis, see below)
- LPS

**Diseases**

*Pertussis*
- "whooping cough"
- catarrhal stage (low-grade fever, myalgias, rhinorrhea and mild non-productive cough, lasts > 2 weeks) → paroxysmal stage (attacks of severe violent non-productive cough followed by an inspiratory gasp ("whoop"), lasts > 4 weeks) → covalescent stage (gradual decrease in number and severity of the attacks, lasts < 4 weeks)
- primarily occurs in neonates
- caused by Bordetella Pertussis colonization of the respiratory tract → secretion of tracheal cytotoxin (see above)

**Treatment**
- macrolides (if in catarrhal stage)
- intubation and mucous removal (if in paroxysmal stage)

## *Bordetella Parapertussis*

**Characteristics**
- same characteristics, toxins, diseases and treatment as Bordetella Pertussis (see above)

**Reservoirs**
- humans (not normal flora)
- animals (primarily sheep)

**Transmission**
- direct contact
- droplet nuclei
- zoonotic

## *Bordetella Bronchiseptica*

**Characteristics**
- motile
- obligate pathogen
- same transmission, toxins, diseases and treatment as Bordetella Parapertussis (see above)

**Reservoirs**
- humans (not normal flora)
- animals (primarily swine, dogs and cats)

# 28. BRUCELLA, FRANCISELLA

## *BRUCELLA*

**Species**
- B. Melitensis
- B. Bovis
- B. Suis

**Characteristics**
- gram -
- pleomorphic rod
- encapsulated
- non-motile
- non-spore forming
- obligate aerobic
- facultative intracellular
- obligate pathogen

**Reservoirs**
- humans (not normal flora)
- animals (primarily sheep (B. Melitensis), cattle (B. Bovis) and swine (B. Suis)

**Transmission**
- zoonotic
- aerosolized ("airborne")
- contaminated food (primarily meat and milk)

**Toxins**
- LPS

**Diseases**

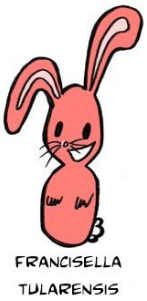
*Brucellosis*
- "undulant fever"
- alternating fever (low in the morning, high in the evening), alternating sweats and chills, headache, arthralgias, hepatosplenomegaly and generalized lymphadenopathy
- lasts for months
- primarily occurs in farmers, abattoir workers and veterinarians
- caused by Brucella septicemia

**Treatment**
- aminoglycosides in conjunction with tetracyclines (due to high antibiotic resistance)
- trimethoprim-sulfamethoxazole

# *FRANCISELLA*

**Characteristics**

- gram -
- pleomorphic bipolar rod
- encapsulated
- non-motile
- non-spore forming
- obligate aerobic
- facultative intracellular




## *Francisella Tularensis*

**Characteristics**

- obligate pathogen

**Reservoirs**

- humans (not normal flora)
- animals (primarily rodents and birds)

**Transmission**

- zoonotic
- aerosolized
- vectorial (mosquitoes, ticks and fleas)
- contaminated food (primarily meat)

**Toxins**

- LPS

**Diseases**

*Ulceroglandular Tularemia*

- "rabbit fever"
- black-based ulcerating papule at the site of initial infection, fever and severe local lymphadenomegaly
- most common (80%)
- analogous to the bubonic plague (see 17)
- caused by initial Francisella Tularensis infection of the skin

*Occuloglandular Tularemia*

- unilateral conjunctivitis, corneal ulcers, fever and severe preauricular and/or cervical lymphadenomegaly
- caused by initial Francisella Tularensis infection of the eye

*Oropharyngeal Tularemia*

- pharyngitis, vomiting, watery diarrhea, fever and severe mesenteric lymphadenomegaly
- caused by ingestion of Francisella Tularensis → initial Francisella Tularensis infection of the oropharynx and GI tract

*Pneumonic (Pulmonary) Tularemia*

- interstitial pneumonitis and/or bronchopneumonia, fever and severe hilar lymphadenomegaly
- > 30% mortality if untreated (!)
- caused by inhalation of Francisella Tularensis → initial Francisella Tularensis infection of the lungs

**Treatment**

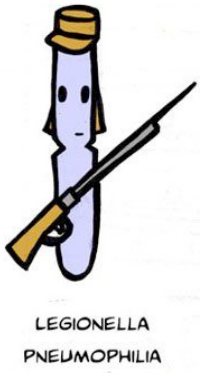
- aminoglycosides
- tetracyclines

# 29. LEGIONELLA

## *LEGIONELLA*

**Characteristics**

- gram -
- rod
- motile
- non-spore forming
- non-encapsulated
- obligate aerobic
- facultative intracellular




## *Legionella Pneumophilia*

**Characteristics**

- obligate pathogen

**Reservoirs**

- humans (not normal flora)
- water

**Transmission**

- aerosolized (through shower heads, air conditioners and cooling towers)

**Toxins**

- LPS

**Diseases**

*Mild Legionellosis*

- "pontiac fever"
- low-grade fever, rhinorrhea, mild non-productive cough and myalgias
- spontaneously resolves in < 1 week
- caused by Legionella Pneumophilia infection of the lungs in healthy

*Severe Legionellosis*

- "legionaire's disease"
- high fever, headache, delirium, severe cavitating bronchopneumonia, hemoptysis, vomiting, watery diarrhea and anorexia
- > 40% mortality if untreated (!)
- caused by Legionella Pneumophilia infection of the lungs in elderly smokers

**Treatment**

- macrolides
- fluoroquinolones

# 30. BACILLUS ANTHRACIS, B. CEREUS

## *BACILLUS*

**Characteristics**

- gram +
- rod
- spore forming (forms a sturdy vegetative infectious particle)
- obligate aerobic
- facultative intracellular

## *Bacillus Anthracis*

**Characteristics**

- encapsulated
- non-motile
- obligate pathogen

**Reservoirs**

- humans (not normal flora)
- animals (primarily horses, cattle, sheep and swine)
- soil (primarily spores)

**Transmission**

- zoonotic
- aerosolized
- vectorial (flies)
- contaminated soil
- contaminated food
- contaminated fomites (primarily wool and hides)

**Toxins**

- lethal factor ("LF", causes ↑ TNF-alpha secretion from macrophages → necrosis of host cells and septic shock → anthrax, see below)

**Diseases**

*Cutaneous Anthrax*

- painless necrotic black-based ulcerating papule
- may complicate by septicemia → septic shock
- > 5% mortality if untreated (!)
- most common
- caused by Bacillus Anthracis infection of the skin

*Gastrointestinal Anthrax*

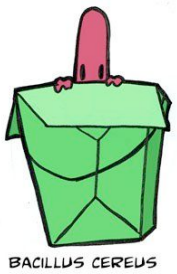
- gastrointestinal necrosis and hemorrhage, abdominal pain, vomiting and bloody diarrhea
- may complicate by septicemia → septic shock
- > 50% mortality if untreated (!)
- caused by ingestion of Bacillus Anthracis → Bacillus Anthracis infection of the GI-tract

*Pulmonary Anthrax*

- severe hilar lymph node necrosis and mediastinal hemorrhage

- may complicate by septicemia → septic shock
- 100% mortality if untreated (!)
- caused by inhalation of Bacillus Anthracis → Bacillus Anthracis infection of the lungs

**Treatment**
- narrow spectrum penicillins
- macrolides




## *Bacillus Cereus*

**Characteristics**
- motile
- <u>non</u>-encapsulated
- obligate pathogen

**Reservoirs**
- humans (<u>not</u> normal flora)
- soil (primarily spores)

**Transmission**
- contaminated food (primarily rice)

**Toxins**
- bacillus heat-labile enterotoxin (analogous to choleragen (see 23) causes diarrheal food poisoning (see below))
- bacillus heat-stabile enterotoxin (analogous to staphylococcal enterotoxin (see 1), causes emetic food poisoning (see below))

**Diseases**

*Diarrheal Food Poisoning*
- diarrheal gastroenteritis (abdominal pain, vomiting and watery diarrhea)
- spontaneously resolves in < 24 hours
- caused by Bacillus Cereus contamination of food → production and secretion of bacillus heat-labile enterotoxin (see above) → ingestion of bacillus heat-labile enterotoxin-contaminated food

*Emetic Food Poisoning*
- emetic gastroenteritis (<u>severe</u> vomiting)
- spontaneously resolves in < 24 hours
- caused by Bacillus Cereus contamination of food → production and secretion of bacillus heat-stabile enterotoxin (see above) → ingestion of bacillus heat-stabile enterotoxin-contaminated food

**Treatment**
- oral fluid and electrolyte replacement

# 31. GAS-GANGRENE CLOSTRIDIA

## *CLOSTRIDIUM*

**Characteristics**

- gram +
- rod
- encapsulated
- spore forming
- <u>non</u>-motile
- obligate anaerobic

### *Clostridium Perfringens*

**Characteristics**

- opportunistic pathogen

**Reservoirs**

- humans (normal flora of the skin, GI tract and female genitalia)
- animals (primarily cattle, swine, poultry and fish)
- soil (primarily spores)

**Transmission**

- direct contact
- fecal-oral
- contaminated soil
- contaminated food

**Toxins**

- clostridium perfringens enterotoxin ("CPE", destroys the tight junctions of the enterocytes → ↑ membrane permeability → ↑ intraluminal osmotic pressure → food poisoning, see below)
- beta-toxin (forms pores in the enterocytes → massive influx of $Ca^{2+}$ → ↑ activation of caspases → apoptosis of the enterocytes → enteritis necroticans, see below)
- alpha-toxin (causes necrosis of host cells → gas gangrene, see below)

**Diseases**

*Food Poisoning*

- gastroenteritis (see 1)
- spontaneously resolves in < 24 hours
- caused by Clostridium Perfringens contamination of food → production and secretion of CPE (see above) → ingestion of CPE-contaminated food

*Enteritis Necroticans*

- abdominal pain, vomiting and bloody diarrhea
- caused by Clostridium Perfringens infection of the GI tract → production and secretion of beta-toxin (see above)

*Gas Gangrene*

- large painful spongy gangrene of skin and muscle containing pockets of gas ("crepitus") and thin black exudate

- caused by Clostridium Perfringens infection of wounds → production and secretion of alpha-toxin (see above)

**Treatment**

- oral water and electrolyte replacement (if gastroenteritis)
- narrow spectrum penicillins (if enteritis necroticans)
- narrow spectrum penicillins in conjunction with surgical excision (if gas gangrene)

*continued in 32…*

# 32. CLOSTRIDIUM TETANI

*...continuation of 31*

## *Clostridium Tetani*

**Characteristics**
- opportunistic pathogen

**Reservoirs**
- humans (normal flora of the GI tract)
- animals
- soil (primarily spores)

**Transmission**
- direct contact
- zoonotic
- contaminated soil

**Toxins**
- tetanus neurotoxin ("TeNT", "tetanospasmin", inhibits neurotransmitter release from inhibitory neurons of motor neurons → constant activation of the motor neurons → tetanus, see below)

**Diseases**

*Tetanus*
- <u>severe</u> painful muscle spasms ("tetany") of the face and neck leading to lockjaw ("trismus") and a sinister grin ("risus sardonicus") → painful muscle spasms of the trunk
- may complicate by painful muscle spasms of the respiratory muscles → death
- > 90% mortality if untreated (!)
- caused by Clostridium Tetani infection of wounds → production and secretion of TeNT (see above) → uptake of TeNT into motor neurons → retrograde axonal transport of TeNT into the CNS

**Treatment**
- narrow spectrum penicillins <u>in conjunction with</u> tetanus antitoxin and surgical excision
- muscle relaxants and intubation (if spasms of the respiratory muscles)

*continued in 33...*

# 33. CLOSTRIDIUM BOTULINUM, C. DIFFICILE

*...continuation of 32*

## *Clostridium Botulinum*

**Characteristics**
- opportunistic pathogen

**Reservoirs**
- humans (normal flora of the GI tract)
- animals (primarily swine and fish)
- water
- soil (primarily spores)

**Transmission**
- contaminated food (primarily smoked meat and canned vegetables)

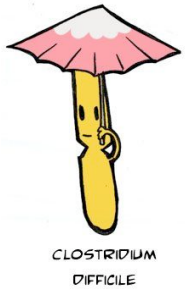
**Toxins**
- botulinum neurotoxin ("BoNT", inhibits acetylcholine release from motor neurons → flaccid paralysis → botulism, see below)

**Diseases**

*Adult Botulism*
- "foodborne botulism"
- flaccid paralysis of the head and neck leading to double vision ("diplopia") and difficulties of swallowing → flaccid paralysis of the trunk
- may complicate by causing flaccid paralysis of the respiratory muscles → death
- > 90% mortality if untreated (!)
- caused by Clostridium Botulinum contamination of food → production and secretion of BoNT (see above) → ingestion of BoNT-contaminated food

*Infantile Botulism*
- "floppy baby syndrome"
- constipation → asthenia and difficulties of swallowing
- caused by Clostridium Botulinum infection of the GI tract → production and secretion of BoNT (see above)

**Treatment**
- botulinum toxin antitoxin (if adult botulism)
- narrow spectrum penicillins (if infantile botulism)
- intubation (if paralysis of the respiratory muscles)




# *Clostridium Difficile*

**Characteristics**
- opportunistic pathogen

**Reservoirs**
- humans (normal flora of the GI tract)
- animals
- water
- soil (primarily spores)
- sand (primarily spores)

**Transmission**
- direct contact
- fecal-oral
- contaminated fomites

**Toxins**
- toxin A ("clostridium difficile enterotoxin", causes watery diarrhea, see below)
- toxin B ("clostridium difficile cytotoxin" , causes necrosis of the simple columnar epithelial cells of the colon → pseudomembrane formation, see below)

**Diseases**

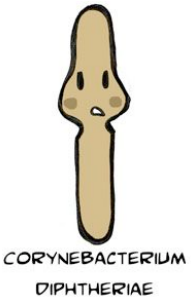
*Pseudomembranous Colitis*
- "antibiotics-associated colitis"
- colitis, pseudomembrane formation (coagulated pus) on the luminal surface of colon and watery purulent diarrhea
- caused by excessive antibiotics treatment with broad spectrum penicillins, cephalosporins and/or lincosamides → elimination of the competing normal bacterial flora in the GI tract → overgrowth of Clostridium Difficile in the GI tract → production and secretion of toxin A and toxin B (see above)

**Treatment**
- metronidazole
- vancomycin

# 34. CORYNEBACTERIUM DIPHTHERIAE

## *CORYNEBACTERIUM*

**Characteristics**
- gram +
- clubbed rod
- non-encapsulated
- non-motile
- non-spore forming
- facultative anaerobic




### *Corynebacterium Diphtheriae*

**Characteristics**
- opportunistic pathogen

**Reservoirs**
- humans (only reservoir, normal flora of the skin and nasopharynx)

**Transmission**
- direct contact
- droplet nuclei

**Toxins**
- diphtheria toxin ("DT", analogous to exotoxin A (see 25), causes diphtheria (see below))

**Diseases**

*Nasopharyngeal Diphtheria*
- low-grade fever, headache, pharyngitis and pseudomembrane formation on the luminal surface of the pharynx → laryngeotracheobroncitis and pseudomembrane formation in the larynx, trachea and bronchi → airway obstruction
- may complicate by diphtheria toxin toxemia → infective myocarditis and peripheral neuropathies
- 10% mortality if untreated (!)
- caused by Corynebacterium Diphtheriae infection of the nasopharynx

*Cutaneous Diphtheria*
- persistent ulcer covered by a grey pseudomembrane
- caused by Corynebacterium Diphtheriae infection of the skin

**Treatment**
- narrow spectrum penicillins in conjunction with diphtheria toxin antitoxin
- intubation (if pseudomembrane formation in the larynx, trachea and brochi)

# 35. LISTERIA, ERYSIPELOTHRIX

## *LISTERIA*

**Characteristics**
- gram +
- rod
- motile
- non-encapsulated
- non-spore forming
- facultative anaerobic
- facultative intracellular

### *Listeria Monocytogenes*

**Characteristics**
- opportunistic pathogen

**Reservoirs**
- humans (normal flora of the GI tract)
- animals
- insects
- water
- soil (primarily mud)

**Transmission**
- direct contact
- sexual
- perinatal
- zoonotic
- contaminated soil
- contaminated food

**Toxins**
- none in particular

**Diseases**

*In Neonates*
- abortion, premature birth and stillbirth
- neonatal meningitis
- granulomatosis infantiseptica (abscess formation and granuloma formation in multiple organs)
- septicemia

*In Elderly and Immunocompromized*
- meningitis and cerebritis
- septicemia

**Treatment**
- broad spectrum penicillins
- aminoglycosides

# *ERYSIPELOTHRIX*

**Characteristics**
- gram +
- rod
- non-encapsulated
- non-motile
- non-spore forming
- facultative anaerobic
- facultative intracellular

## *Erysipelothrix Rhusiopathiae*

**Characteristics**
- obligate pathogen

**Reservoirs**
- humans (not normal flora)
- animals (primarily swine, poultry, fish and birds)
- water
- soil

**Transmission**
- zoonotic
- contaminated food
- contaminated soil

**Toxins**
- none in particular

**Diseases**

*Cutaneous Erysipeloid*
- burning erythematous papule at the site of initial infection and low-grade fever
- caused by Erysipelothrix Rhusiopathiae infection of wounds
- may progress to diffuse erysipeloid (see below)

*Diffuse Erysipeloid*
- multiple burning red erythematous papules with necrotic centers, headache, myalgias and arthralgias
- caused by progression of cutaneous erysipeloid (see above)
- may progress to septicemic erysipeloid (see below)

*Septicemic Erysipeloid*
- subacute infectious endocarditis and arthritis
- caused by progression of diffuse erysipeloid (see above) or by Erysipelothrix Rhusiopathiae infection of the GI tract → Erysipelothrix Rhusiopathiae septicemia

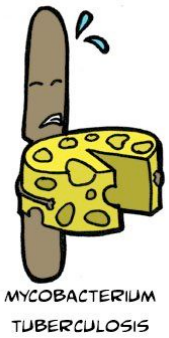
**Treatment**
- narrow spectrum penicillins
- broad spectrum penicillins

# 36. MYCOBACTERIUM TUBERCULOSIS, M. BOVIS
# 37. ANTI-TUBERCULOSIS TREATMENT

## *MYCOBACTERIUM*

**Characteristics**

- acid-fast (stains red with acid-fast stain) gram +
- rod
- non-encapsulated
- non-motile
- non-spore forming
- obligate aerobic
- facultative intracellular




### *Mycobacterium Tuberculosis*

**Characteristics**

- obligate pathogen

**Reservoirs**

- humans (only reservoir, not normal flora)

**Transmission**

- droplet nuclei

**Toxins**

- none in particular

**Diseases**

*Primary Tuberculosis*

- several medium-sized caseating calcifying granulomas in the middle and lower lobes of the lungs ("gohn focus") and several medium-sized caseating calcifying granulomas in the hilar lymph nodes ("gohn complex")
- caused by primary Mycobacterium Tuberculosis infection of the lungs
- may progress to pulmonary miliary tuberculosis, extrapulmonary miliary tuberculosis, pulmonary reactivation tuberculosis and/or extrapulmonary reactivation tuberculosis (see below)

*Pulmonary Miliary Tuberculosis*

- hundrends of tiny caseating calcifiying granulomas throughout the lung parenchyma
- primarily occurs in neonates and in immunocompromized
- caused by absent or incomplete healing of the gohn compexes → spread of the Mycobacterium Tuberculosis by the pulmonary lymphatics → reentrance of Mycobacterium Tuberculosis through the pulmonary arteries

*Extrapulmonary Miliary Tuberculosis*

- hundreds of tiny caseating calcifying granulomas throughout the base of the brain, liver, spleen and kidneys
- primarily occurs in neonates and in immunocompromized
- caused by absent or incomplete healing of the gohn compexes →

spread of the Mycobacterium Tuberculosis by the pulmonary veins → entrance of Mycobacterium Tuberculosis into the systemic circulation

*Pulmonary Reactivation Tuberculosis*

- low-grade fever, multiple large caseating cavitating granulomas and large hemorrhaging cavernae in the upper lobes of the lungs, productive cough and hemoptysis
- caused by escape of dormant Mycobacterium Tuberculosis bacteria from the healed gohn complexes (see above) → spread of the Mycobacterium Tuberculosis by the pulmonary lymphatics (see above)

*Extrapulmonary Reactivation Tuberculosis*

- meningitis and multiple medium-sized caseating granulomas in the brain
- pleuritis, pericarditis and peritonitis
- multiple medium-sized caseating granulomas in the kidneys
- orchidoepididymitis, oophoritis and multiple medium-sized caseating granulomas in the testes and ovaries
- spondylitis of the vertebral bodies and multiple medium-sized caseating granulomas in the intervertebral discs ("pott's disease")
- caused by escape of dormant Mycobacterium Tuberculosis for the healed gohn complexes → spread of the Mycobacterium Tuberculosis by the pulmonary veins (see above)

**Treatment**

*Primary Phase*

- isoniazid in conjunction with rifampin and pyrazinamide (as well as ethambutol if high antibiotic resistance)
- lasts 2 months

*Secondary Phase*

- isoniazid in conjunction with rifampin
- lasts 4 months (6 months if high antibiotic resistance)

## *Mycobacterium Bovis*

**Characteristics**

- obligate pathogen
- same toxins, diseases and treatment as Mycobacterium Tuberculosis (see above)

**Reservoirs**

- humans (not normal flora)
- animals (primarily cattle, primates and rodents)

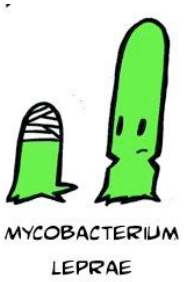
**Transmission**

- droplet nuclei
- zoonosis
- contaminated food (primariy meat and milk)

*continued in 38…*

# 38. MYCOBACTERIUM LEPRAE AND OTHER NON-TUBERCULOUS MYCOBACTERIA

*...continuation of 36/37*




## *Mycobacterium Leprae*

**Characteristics**
- obligate pathogen

**Reservoirs**
- humans (not normal flora)
- animals (possibly armadillos)

**Transmission**
- direct contact
- droplet nuclei
- zoonosis

**Toxins**
- none in particular

**Diseases**

*Paucibacillary Leprosy*
- "tuberculoid leprosy"
- < 5 medium-sized granular hairless hypopigmented non-healing skin lesions → local peripheral nerve thickening leading to partial loss of sensation and asthenia in the affected areas
- caused by Mycobacterium Leprae infection of the skin in healthy

*Multibacillary Leprosy*
- "lepromatous leprosy"
- > 5 large nodular hairless hypopigmented non-healing skin lesions leading to destruction of the nasal cartilage and deformation of the face ("leonine facies") → multiple medium-sized granulomas in the liver, spleen and lymph nodes leading to hepatosplenomegaly and generalized lymphadenomegaly → generalized peripheral nerve thickening leading to complete loss of sensastion and paralysis of the arms and legs → unconscious damage and secondary infections of the arms and legs leading to loss of fingers and toes
- caused by Mycobacterium Leprae infection of the skin in immunocompromized

**Treatment**

*Paucibacillary Leprosy*
- dapsone in conjunction with rifampin
- lasts 6 months

*Multibacillary Leprosy*
- dapsone in conjunction with rifampin and clofazimine
- lasts 2 years

# *Mycobacterium Avium & M. Intracellulare*

**Characteristics**
- opportunistic pathogen

**Reservoirs**
- humans (not normal flora)
- animals (primarily cattle, swine and birds)
- water
- soil

**Transmission**
- zoonotic
- aerosolized
- contaminated water
- contaminated food

**Toxins**
- none in particular

**Diseases**

*Pulmonary Mycobacterium Avium-Intracellulare Complex*
- “”pulmonary MAC”
- low-grade fever and productive cough
- primarily occurs if viral interstitial pneumonitis and/or chronic bronchitis is already present
- caused by MAC infection of the lungs

*Gastrointestinal Mycobacterium Avium-Intracellulare Complex*
- “gastrointestinal MAC”
- low-grade fever and watery diarrhea
- primarily occurs in immunocompromized
- caused by MAC infection of the GI tract
- may progress to disseminated MAC (see below)

*Disseminated Mycobacterium Avium-Intracellulare Complex*
- “disseminated MAC”
- high fever, severe anorexia, severe anemia, hepatosplenomegaly and generalized lymphadenomegaly
- caused by progression of gastrointestinal MAC (see above) → MAC septicemia

**Treatment**
- aminoglycosides
- macrolides

# 39. TREPONEMA PALLIDUM

## *TREPONEMA*

**Characteristics**

- gram -
- spirochete (helically-coiled cell)
- motile
- non-spore forming
- non-encapsulated
- microaerophilic

TREPONEMA PALLIDUM

## *Treponema Pallidum*

**Characteristics**

- obligate pathogen

**Reservoirs**

- humans (only reservoir, not normal flora)

**Transmission**

- direct contact
- sexual
- perinatal

**Toxins**

- none in particular (not even LPS (!))

**Diseases**

*Primary Syphilis*

- a single small painless depressed ulcer with elevated margins ("chancre") at the site of initial infection, fever, headache, anorexia and local lymphadenomegaly
- primarily occurs on the external genitalia, periorally (if oral intercourse) or perianally (if anal intercourse)
- occurs 3-6 weeks after initial infection
- spontaneously resolves in 3-6 weeks
- caused by Treponema Pallidum infection of the skin
- may progress to secondary syphilis (see below)

*Secondary Syphilis*

- small flat erythematous rashes of the palms and soles, small painless papules ("condyloma lata") of the groin and axilla, and generalized lymphadenomegaly
- occurs 12-18 weeks after initial infection
- spontaneously resolves in 3-6 weeks
- caused by Treponema Pallidum septicemia
- may progress to tertiary syphilis (see below)

*Tertiary Syphilis*

- nodular well circumscribed caseating granulomas ("gummas") of the skin, liver and bone, obliterative endarteritis of the vasa vasorum leading to aortic aneurysm ("cardiovascular syphilis"), meningitis, obliterative endarteritis of the cerebral arteries leading

to cerebral infarct, and permanent central neuronal damage leading to general paresis and tabes dorsalis ("neurosyphilis")
- occurs 3-15 years after initial infection
- occurs in 30% of untreated patients
- caused by Treponema Pallidum accumulation in tissues

*Early Congenital Syphilis*
- small flat erythematous rashes of the palms and soles, condyloma lata (see above) of the groin and axilla, osteitis, rhinitis (snuffles"), hepatosplenomegaly and generalized lymphadenomegaly
- occurs immediately after birth
- spontaneously resolves in 1-3 weeks
- caused by intrauterine Treponema Pallidum infection → Treponema Pallidum septicemia
- may progress to late congenital syphilis (see below)

*Late Congenital Syphilis*
- gummas (see above) of the cartilage of the nose, the bone of the hard palate and the teeth leading to deformation of the face ("bulldog facies"), gummas of the tibia and fibula leading to deformation of the legs ("saber shins"), and neurosyphilis (see above)
- occurs 1-3 years after birth
- caused by Treponema Pallidum accumulation in tissues

**Treatment**
- narrow spectrum penicillins
- tetracyclines

# 40. BORRELIA

## *BORRELIA*

**Characteristics**

- gram -
- spirochete
- motile
- non-spore forming
- non-encapsulated
- microaerophilic

### *Borrelia Burgdorferi*

**Characteristics**

- obligate pathogen

**Reservoirs**

- humans (not normal flora)
- animals (primarily deer and rodents)

**Transmission**

- vectorial (ticks)

**Toxins**

- none in particular

**Diseases**

*Early Localized Lyme Disease*

- a single large round flat painless enlarging erythematous rash with central necrosis ("erythema chronicum migrans") at the site of initial infection, fever, headache, myalgias, and local lymphadenomegaly
- occurs 1 week after initial infection
- spontaneously resolves in < 1 month
- caused by Borrelia Burgdorferi infection of the skin
- may progress to early disseminated lyme disease (see below)

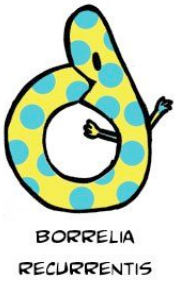
*Early Disseminated Lyme Disease*

- disseminated small erythema chronicum migrans (see above), relapsing arthritis, carditis leading to AV block, meningitis, cranial nerve damage leading to cranial nerve neuropathies, peripheral nerve damage leading to peripheral neuropathies, and generalized lymphadenomegaly
- occurs 1-3 months after initial infection
- caused by Borrelia Burgdorferi septicemia
- may progress to late disseminated lyme disease (see below)

*Late Disseminated Lyme Disease*

- chronic arthritis and permanent central neuronal damage leading to encephalopathies
- occurs 3-6 months after initial infection
- occurs in 10% of untreated patients
- caused by Borrelia Burgdorferi accumulation in tissues

**Treatment**
- broad spectrum penicillins (if early localized lyme disease and/or early disseminated lyme disease)
- third generation cephalosporins (if late disseminated lyme disease)




## *Borrelia Recurrentis*

**Characteristics**
- obligate pathogen

**Reservoirs**
- humans (only reservoir, not normal flora)

**Transmission**
- vectorial (body lice)

**Toxins**
- none in particular

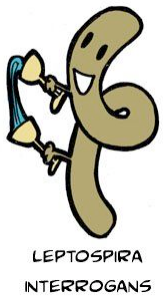
**Diseases** *Relapsing Fever*
- high fever, headache, myalgias and disseminated skin rashes for < 1 week → afebrile period for > 1 week → progressively shorter and milder periods of fever and progressively longer afebrile periods until it completely disappears
- caused by Borrelia Recurrentis septicemia

**Treatment**
- narrow spectrum penicillins
- tetracyclines

# 41. LEPTOSPIRA

## *LEPTOSPIRA*

**Characteristics**
- gram -
- spirochette
- motile
- non-encapsulated
- non-spore forming
- obligate aerobic




### *Leptospira Interrogans*

**Characteristics**
- obligate pathogen

**Reservoirs**
- humans (not normal flora)
- animals

**Transmission**
- zoonotic
- aerosolized
- contaminated water
- contaminated soil
- contaminated food

**Toxins**
- none in particular

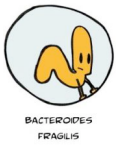
**Diseases**

*Anicteric Leptospirosis*
- "fort bragg fever"
- spiking fever, headache and myalgias (primarily of the calves, back and abdomen) → meningitis (usually subclinical)
- most common
- caused by Leptospira Interrogans infection of the GI tract → mild septicemia

*Icteric Leptospirosis*
- "weil's disease"
- enterocolitis (see 14) and mesenteric lymphadenitis ("mock appendicitis") → meningitis, infectious interstitial nephritis leading to intrarenal acute renal failure and uremia, and hepatitis leading jaundice and coagulopathies
- caused by Leptospira Interrogans infection of the GI tract → severe septicemia

**Treatment**
- narrow spectrum penicillins
- broad spectrum penicillins

# 42. BACTEROIDES, FUSOBACTERIUM AND VEILLONELLA




## *BACTEROIDES*

**Species**
- B. Fragilis
- B. Ovatus
- B. Vulgatus

**Characteristics**
- gram -
- pleomorphic rod
- encapsulated
- motile or non-motile depending on the species
- non-spore forming
- obligate anaerobic
- opportunistic pathogen

**Reservoirs**
- humans (normal flora of the nasopharynx, oropharynx, oral cavity, GI tract (99% of the normal flora of the GI tract (!)), and female genitalia)
- animals

**Transmission**
- trauma
- zoonosis

**Toxins**
- none in particular (not even LPS (!))

**Diseases**
- otitis media and mastoiditis
- sinusitis
- gingivitis and periodontitis
- pharyngitis and retropharyngeal abscesses
- bronchopneumonia and pulmonary abscesses
- peritonitis, subphrenic abscesses and hepatic abscesses
- vulvovaginitis and pelvic inflammatory disease
- meningitis and cerebral abscesses
- subacute infectious endocarditis
- osteomyelitis and infective arthritis
- septicemia

**Treatment**
- metronidazole
- lincosamides

## *FUSOBACTERIUM*

**Species**
- F. Necrophorium
- F. Nucleatum
- F. Polymorphum

**Characteristics**
- same characteristics, reservoirs, transmission, toxins, diseases and treatment as Bacteroides (see above)

## *VEILLONELLA*

**Species**
- V. Atypica
- V. Dispar
- V. Parvula

**Characteristics**
- gram -
- curved coccus
- encapsulated
- non-motile
- non-spore forming
- obligate anaerobic
- opportunistic pathogen
- same reservoirs, transmission and toxins as Bacterioides (see above)

**Diseases**
- gingivitis and periodontitis
- pharyngitis and retropharyngeal abscesses
- bronchopneumonia and pulmonary abscesses
- meningitis and cerebral abscesses
- subacute infectious endocarditis
- osteomyelitis and infective arthritis (primarily if prosthetic joints)
- septicemia (primarily if central venous catheter)

**Treatment**
- narrow spectrum penicillins
- broad spectrum penicillins

# 43. RICKETTSIA

## *RICKETTSIA*

**Characteristics**
- gram -
- pleomorphic rod
- encapsulated
- non-motile
- non-spore forming
- obligate aerobic
- obligate intracellular (only survives intracellulary)

### *Rickettsia Rickettsii*

**Characteristics**
- obligate pathogen

**Reservoirs**
- humans (not normal flora)
- animals (primarily dogs and rodents)

**Transmission**
- zoonotic
- vectorial (ticks)

**Toxins**
- LPS

**Diseases** *Rocky Mountain Spotted Fever*
- fever, headache, myalgias, and maculopapular rashes beginning on the palms and soles and then progressing towards the trunk
- spontaneously resolves in < 3 weeks
- 20% mortality if untreated (!)
- caused by Rickettsia Rickettsii septicemia

**Treatment**
- tetracyclines
- chloramphenicol

### *Rickettsia Prowazekii*

**Characteristics**
- obligate pathogen

**Reservoirs**
- humans (not normal flora)
- animals (possibly flying squirrels)

**Transmission**
- zoonotic
- vectorial (body lice)

**Toxins**
- LPS

**Diseases**

*Acute Epidemic Typhus*

- fever, headache, myalgias and maculopapular rashes beginning on the trunk and then progressing towards the extremities (except the palms, soles and face)
- spontaneously resolves in < 3 weeks
- 10% mortality if untreated (!)
- caused by Rickettsia Prowazekii septicemia
- may progress to chronic epidemic typhus (see below)

*Chronic Epidemic Typhus*

- "brill-zinsser disease"
- fever, headache and myalgias
- occurs years after initial infection
- caused by reactivation of latent Rickettsia Prowazekii → Rickettsia Prowazeki septicemia

**Treatment**

- tetracyclines
- chloramphenicol

## *Rickettsia Typhi*

**Characteristics**

- obligate pathogen

**Reservoirs**

- humans (not normal flora)
- animals (primarily rodents)

**Transmission**

- zoonotic
- vectorial (fleas)

**Toxins**

- LPS

**Diseases**

*Endemic Typhus*

- similar to epidemic typhus (see above)
- caused by Rickettsia Prowazekii septicemia

**Treatment**

- tetracyclines
- chloramphenicol

## *Rickettsia Akari*

**Characteristics**

- obligate pathogen

**Reservoirs**

- humans (not normal flora)
- animals (primarily rodents)

**Transmission**

- zoonotic
- vectorial (mites)

**Toxins**
- LPS

**Diseases**

*Rickettsialpox*
- small erythematous vescicular papule at the site of initial infection → fever, headache and disseminated small erythematous vesicular papules
- spontaneously resolves in < 1 week
- caused by Rickettsia Akari septicemia

**Treatment**
- tetracyclines
- chloramphenicol

# 44. COXIELLA, BARTONELLA

## *COXIELLA*

**Characteristics**
- gram -
- pleomorphic rod
- spore forming
- non-motile
- non-encapsulated
- obligate aerobic
- obligate intracellular

### *Coxiella Burnetti*

**Characteristics**
- obligate pathogen

**Reservoirs**
- humans (not normal flora)
- animals (primarily cattle and sheep)

**Transmission**
- zoonotic
- aerosolized
- contaminated food (primarily milk)

**Toxins**
- LPS

**Diseases**

*Acute Pulmonary Q Fever*
- fever, headache and interstitial pneumonitis
- caused by Coxiella Burnetti infection of the lungs
- may progress to chronic q fever (see below)

*Acute Gastrointestinal Q Fever*
- fever, headache and hepatitis
- caused by Coxiella Burnetti infection of the GI tract
- may progress to chronic q fever (see below)

*Chronic Q Fever*
- fever, headache and subacute infectious endocarditis
- occurs years after initial infection
- caused by reactivation of latent Coxiella Burnetti → Coxiella Burnetti septicemia

**Treatment**
- tetracyclines
- chloramphenicol

# *BARTONELLA*

**Characteristics**

- gram -
- pleomorphic rod
- motile
- non-spore forming
- non-encapsulated
- obligate aerobic
- facultative intracellular

## *Bartonella Henselae*

**Characteristics**

- obligate pathogen

**Reservoirs**

- humans (not normal flora)
- animals (primarily cats)

**Transmission**

- zoonotic
- vectorial (fleas)

**Toxins**

- none in particular

**Diseases**

*Cat Scratch Disease*

- a single purulent papular lesion at the site of initial infection, low grade fever and local lymphadenomegaly
- spontaneously resolves in < 3 months
- caused by Bartonella Henselae infection of the skin
- may progress to bacillary angiomatosis and/or bacillary peliosis (see below)

*Bacillary Angiomatosis*

- cystic congested vascular proliferations in the skin and mucous membranes
- primarily occurs in immunocompromized
- caused by Bartonella Henselae infection of vascular endothelium

*Bacillary Peliosis*

- cystic congested vascular proliferations in the liver and spleen
- primarily occurs in immunocompromized
- caused by Bartonella Henselae infection of vascular endothelium

**Treatment**

- tetracyclines in conjunction with surgical drainage (if cat scratch disease)
- tetracyclines (if bacillary angiomatosis and/or bacillary peilosis)

# *Bartonella Quintana*

**Characteristics**
- obligate pathogen

**Reservoirs**
- humans (only reservoir, not normal flora)
-

**Transmission**
- vectorial (body lice)

**Toxins**
- none in particular

**Diseases**

*Acute Trench Fever*
- high fever, headache, myalgias (primarily of the calves, back and abdomen) and skin rashes for < 1 week → afebrile period for > 2 weeks → progressively shorter and milder periods of fever and progressively longer afebrile periods until it completely disappears
- primarily occurs in homeless
- analogous to relapsing fever (see 40)
- caused by Bartonella Quintana septicemia
- may progress to chronic trench fever, bacillary angiomatosis and/or bacillary peliosis (see below)

*Chronic Trench Fever*
- relapsing high fever, headache, myalgias and skin rashes in conjunction with subacute infectous endocarditis, hepatic abscesses and splenic abscesses
- primarily occurs in immunosuppressed
- caused by progression of acute trench fever (see above)

*Bacillary Angiomatosis*
- see above

*Bacillary Peliosis*
- see above

**Treatment**
- tetracyclines
- macrolides

# 45. CHLAMYDIA

## *CHLAMYDIA*

**Characteristics**

- gram -
- coccus
- spore forming
- non-motile
- non-encapsulated
- obligate aerobic
- obligate intracellular

## *Chlamydia Trachomatis*

**Characteristics**

- obligate pathogen

**Reservoirs**

- humans (only reservoir, not normal flora)

**Transmission**

- direct contact
- sexual
- perinatal

**Toxins**

- LPS

**Diseases**

*In Males*

- most common cause of non-gonococcal urethritis ("chlamydia")
- prostatitis and epididymitis

*In Females*

- most common cause of non-gonococcal urethritis and cervicitis ("chlamydia")
- pelvic inflammatory disease, tuboovarian abscesses, ectopic pregnancies and infertility

*In Both Males and Females*

- trachoma ("follicular keratoconjunctivitis") and blindness
- lymphogranuloma venerum (painless ulcer at the site of initial infection and local lymphadenitis), rectal stricture and elephantiasis
- reiter's syndrome (septic oligoarthritis of the large joints)
- septicemia

*In Neonates*

- conjunctivitis and blindness
- neonatal interstitial penumonitis

**Treatment**

- tetracyclines in conjunction with third generation cephalosporins (if non-gonococcal urethritis and/or cervicitis, due to the possibility that the urethritis and/or cervicitis may be of Neisseria

Gonorrhoeae (see 10) and/or Ureaplasma Urealyticum (see 46) origin)
- tetracyclines (if trachoma and/or conjunctivitis)
- macrolides (if neonatal interstitial pneumonitis)

## *Chlamydia Psittaci*

**Characteristics**
- obligate pathogen

**Reservoirs**
- humans (<u>not</u> normal flora)
- animals (primarily birds)

**Transmission**
- zoonotic
- aerosolized

**Toxins**
- LPS

**Diseases**

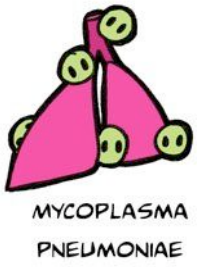
*Parrot Fever*
- "psittacosis"
- fever, headache, myalgias and interstitial pneumonitis
- caused by Chlamydia Psittaci infection of the lungs

**Treatment**
- tetracyclines
- macrolides

# 46. MYCOPLASMA, UREAPLASMA

## *MYCOPLASMA*

**Characteristics**
- gram -
- pleomorphic (neither coccus nor rod, due to no cell wall (!))
- motile (but has no flagella, unknown mechanism (!))
- non-spore forming
- non-encapsulated
- facultative anaerobic




### *Mycoplasma Pneumoniae*

**Characteristics**
- obligate pathogen

**Reservoirs**
- humans (only reservoir, not normal flora)

**Transmission**
- direct contact
- droplet nuclei
- contaminated fomites

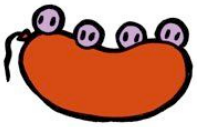
**Toxins**
- none in particular

**Diseases**
- most common BACTERIAL cause of interstitial pneumonitis
- pharyngitis and tracheobronchitis
- wound infections (primarily if surgical)
- meningitis and cerebritis
- subacute infectious endocarditis and acute pericarditis
- infective arthritis
- septicemia

**Treatment**
- tetracyclines
- macrolides

## *UREAPLASMA*

**Characteristics**
- gram -
- pleomorphic (neither coccus nor rod, due to no cell wall (!))
- non-encapsulated
- non-motile
- non-spore forming
- facultative anaerobic




# *Ureaplasma Urealyticum*

**Characteristics**
- opportunistic pathogen

**Reservoirs**
- humans (only reservoir, normal flora of the female genital tract)

**Transmission**
- sexual

**Toxins**
- none in particular

**Diseases**

*In Males*
- second most common cause of non-gonococcal urethritis (after Chlamydia Trachomatis, see 45)
- prostatitis and epididymitis

*In Females*
- second most common cause of non-gonococcal urethritis and cervicitis (after Chlamydia Trachomatis, see 45)
- pelvic inflammatory disease, tuboovarian abscesses, ectopic pregnancies and infertility

*In Both Males and Females*
- cystitis and pyelonephritis
- wound infections (primarily if surgical)
- infective arthritis
- septicemia

*In Neonates*
- neonatal interstitial pneumonitis
- neonatal meningitis
- septicemia

**Treatment**
- tetracyclines in conjunction with third generation cephalosporins (if non-gonococcal urethritis and/or cervicitis, due to the possibility that the urethritis and/or cervicitis may be of Neisseria Gonorrhoeae (see 10) and/or Chlamydia Trachomatis (see 45) origin)
- tetracycline (if all other diseases)